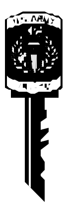
LESSON 6: DETERMINING DIRECTION

PURPOSE

Directions play an important role in everyday life. People oftentimes express them as right, left, straight ahead, and so forth; but then the question arises, "to the right of what?" To answer that question, this lesson first defines different types of azimuths and three different types of north, then it explains how to determine grid and magnetic azimuths using a protractor and compass.



azimuth
back azimuth
degree
graduated
grid azimuth
grid north
magnetic azimuth
magnetic north
mil (s)
true north

INTRODUCTION

In the last lesson, you learned how to determine the distance between two points. Once you have determined this distance, you have part of the information you need to get where you are going. In order to reach your destination, however, you still need to know what direction to travel.

EXPRESSING DIRECTIONS

We express direction as a unit of angular measure. The most common unit of measure is the **degree**. There are 360 degrees in a circle. Each degree is subdivided into 60 minutes and each minute into 60 seconds.

To express direction as a unit of angular measure, there must be a starting point (or zero measurement) and a point of reference. These two points designate the base direction or reference line. There are three base directions — **true north**, **magnetic north**, and **grid north**. Although you will only be using magnetic and grid north in this lesson, we have defined and illustrated all three base directions below.

- True north is a line from any point on the earth's surface to the north pole. All lines of longitude are true north lines. Mapmakers normally represent true north in the marginal information with a star .

- Magnetic north is the direction to the north magnetic pole, as shown by the north-seeking needle of a compass or other magnetic instrument. Mapmakers usually illustrate magnetic north in the marginal information by a line ending with a half arrow-head.

- Grid north is the north that mapmakers establish with the vertical grid lines on a map. They usually illustrate it by placing the letters "GN" on a vertical line in the marginal information.

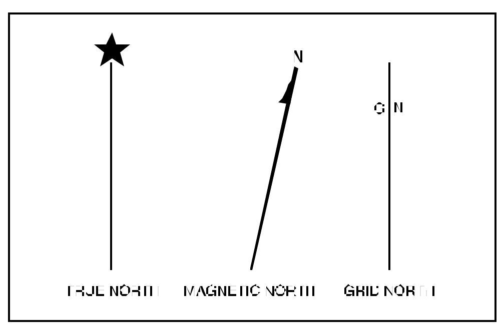


Illustration 2.6.1

AZIMUTHS

An **azimuth** is defined as a horizontal angle measured clockwise from a base direction. The azimuth is the most common military method to express direction. When using an azimuth, the point from which the azimuth originates is the center of an imaginary circle (see Illustration 2.6.2).

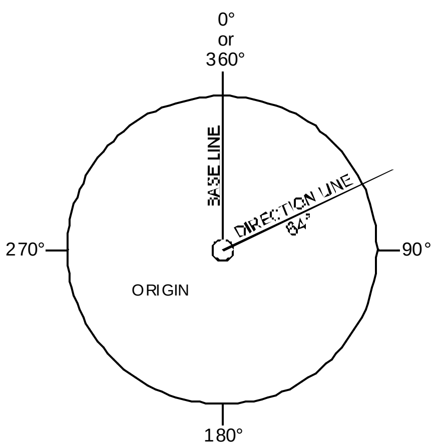


Illustration 2.6.2

There are three distinct ways to express an azimuth: **back azimuth**, **magnetic azimuth**, and **grid azimuth**. Following the definition of these azimuths, the remainder of this lesson will explain how to measure magnetic and grid azimuths.

- A back azimuth is the opposite direction of an azimuth. It is just like doing an "about face." To obtain a back azimuth from an azimuth, *add* 180 degrees if the azimuth is 180 degrees or less; or *subtract* 180 degrees if the azimuth is 180 degrees or more (see Illustration 2.6.3). The back azimuth of 180 degrees may be stated as 0 degrees or as 360 degrees.

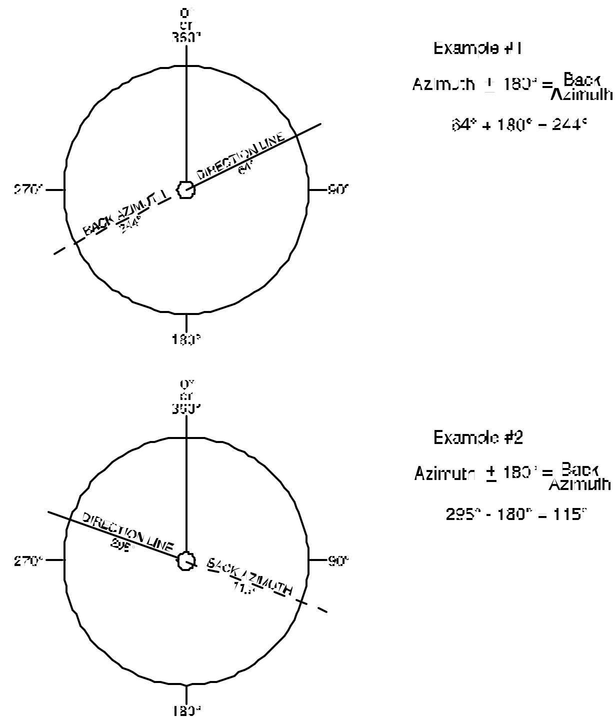


Illustration 2.6.3

- A magnetic azimuth is a direction expressed as the angular difference between magnetic north and the direction line (see Illustration 2.6.4). We determine a magnetic azimuth using a compass or other magnetic instrument (such as surveying equipment).

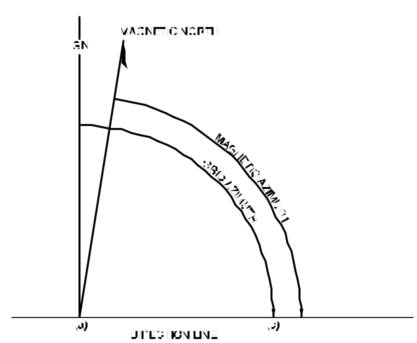


Illustration 2.6.4

- A grid azimuth is the angle measured between grid north and a straight line plotted between two points on a map (see points "a" and "b" in Illustration 2.6.4).

You would use a protractor to measure this angle.

TYPES OF COMPASSES

The Magnetic Lensatic Compass

You determine a magnetic azimuth with the use of a compass. However, before explaining how to measure a magnetic azimuth, we will first introduce you to two types of compasses. The magnetic lensatic compass (see Illustration 2.6.5), used by the military, is the most common and simplest instrument for measuring direction. It has three major parts: cover, base, and lens.

- Cover. The cover protects the floating dial. It contains the sighting wire (front sight) and two luminous sighting slots or dots used for night navigation.

- Base. The base contains the following movable parts.

⇒ The floating dial is mounted on a pivot so it can rotate freely when you hold the compass level. Printed on the dial in luminous figures are an arrow and the letters E and W or E, W, and S. The arrow always points to magnetic north and the letters fall at East (90 degrees), South (180 degrees), and/or West (270 degrees). There are two scales. The outer denotes **mils** and the inner scale (normally in red) denotes degrees.

⇒ Encasing the floating dial is a glass containing a fixed black index line.

⇒ The bezel ring is a ratchet device that clicks when turned. It contains 120 clicks when rotated fully. Each click is equal to 3 degrees. A short luminous line used in conjunction with the north-seeking arrow is contained in the glass face of the bezel ring.

⇒ The base also contains the thumb loop.

- Lens. Use the lens to read the dial. The rear sight also serves as a lock and clamps the dial when closed. You must open the rear sight more than 45 degrees to allow the dial to float freely. There is also a rear-sight slot used for sighting on objects. Use this with the front sight sighting wire.

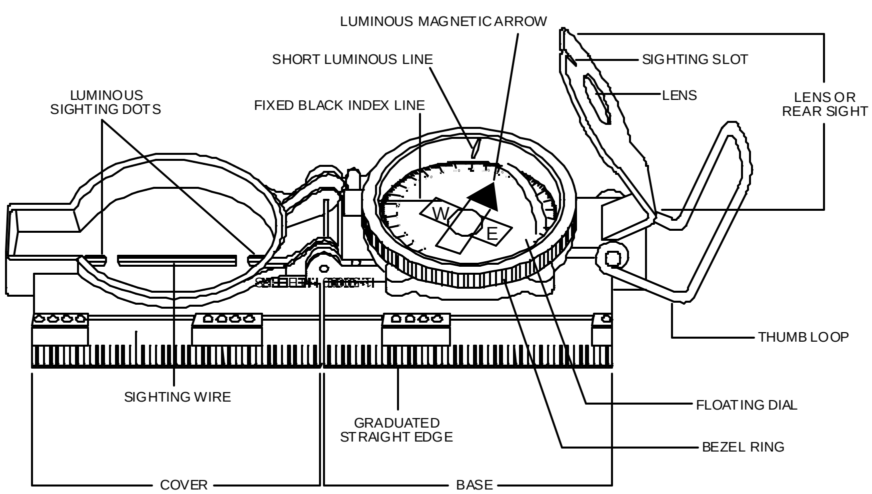


Illustration 2.6.5

The Silva Compass

The *Silva Polaris* (*Type 7*) precision compass (see Illustration 2.6.6) is also one of the most accurate compasses on the market today. Some high schools prefer it over the military issued, magnetic lensatic compass due to its cost and availability. The *Silva* compass is easy to use, especially with its hand-contoured base plate. It is typically available at certain discount department stores for just under $10. Shown below is the actual size of the *Silva Polaris* (*Type 7*) compass along with its eight features.

⇒ The floating needle is mounted on a pivot so that it can rotate freely when you hold the compass level. It settles within four seconds, always pointing to magnetic north.

⇒ Printed distinctly on the rotating dial are the letters N and S, to represent 0/360 degrees and 180 degrees, respectively. The dial is graduated at two degree intervals, marked at 20 degree intervals, and contains the letters E (at 90 degrees) and W (at 270 degrees).

⇒ The base plate contains two rulers (one measured in inches and the other in millimeters). It also has a 40-degree east and west declination scale inside the area of the floating dial.

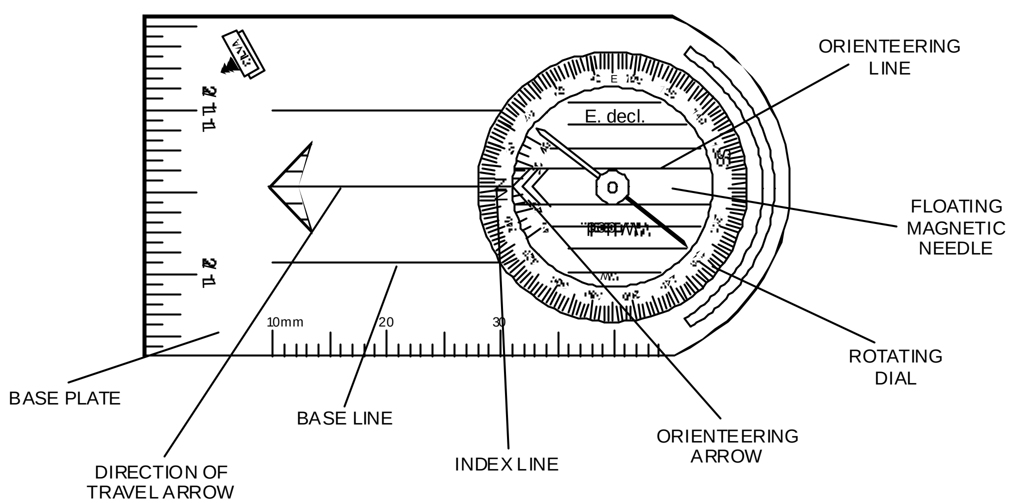


Illustration 2.6.6

MEASURING A MAGNETIC AZIMUTH

The following steps explain how to determine a magnetic azimuth using the centerhold technique (see Illustration 2.6.7). This method is the fastest and easiest way to measure a magnetic azimuth. There is also a compass-to-cheek technique as well as ways for presetting a compass; however, we will not cover those procedures in this unit.

1. First, open the compass to its fullest so that the cover forms a straightedge with the base.

2. Move the lens (rear sight) to the rearmost position, allowing the dial to float freely.

3. Next, place your thumb through the thumb loop, form a steady base with your third and fourth fingers, and extend your index finger along the side of the compass. Place the

thumb of the other hand between the lens (rear sight) and the bezel ring. Extend the index finger along the remaining side of the compass, and the remaining fingers around the fingers of the other hand.

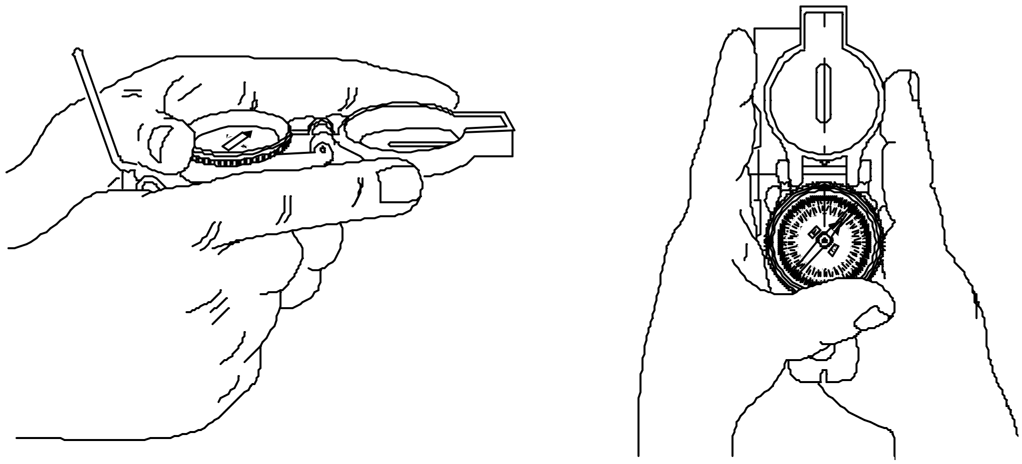


Illustration 2.6.7

4. Pull your elbows firmly into your sides. This action will place the compass between your chin and waist.

5. To measure an azimuth, simply turn your entire body toward the object, pointing the compass cover (zero or index mark) directly at the object.

6. Once you are pointing at the object, look down and read the azimuth from beneath the fixed black index line. Illustration 2.6.8 shows a magnetic azimuth of 320 degrees.

IMPORTANT NOTES:

- The six steps discussed above are for the magnetic lensatic compass. For the *Silva* compass, modify step 3 to hold it either completely in one hand (with the curved end toward the back of the palm) or with both hands (as shown in Illustration 2.6.7, but disregarding the information on thumb loop and rear sight.

- Ensure that you are away from power lines, vehicles, or other metal objects when using a compass because these objects will affect its accuracy.

- Some compasses may have a 1:25,000 scale; you can still use this scale with a 1:50,000 scale map, but you must halve the values read.

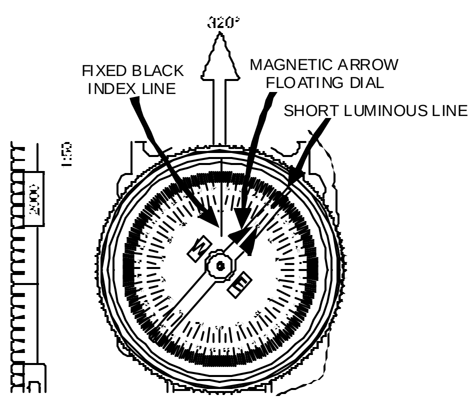


Illustration 2.6.8

USING PROTRACTORS

You determine a grid azimuth with the use of a protractor. There are several types of protractors: full circle, half circle, square, or rectangular. All of them divide the circle into units of angular measure, and each has a scale around the outer edge and an index mark. The index is the center of the protractor circle from which you measure all directions.

On the military protractor, you read the inner of two scales because it is **graduated** into degrees — from 0 to 360 degrees. Each tick mark on the degree scale represents one degree. The base line of this protractor is a line from 0 degrees to 180 degrees. Where the base line intersects the horizontal line, between 90 degrees and 270 degrees, is the index or center of the protractor.

When using the protractor, the base line is always oriented parallel to a north-south grid line. The 0- or 360-degree mark is toward the top or north on the map, and the 90-degree mark is to the right. Steps for determining and plotting grid azimuths are explained below.

MEASURING A GRID AZIMUTH

The following steps explain how to measure a grid azimuth using a map and protractor (see Illustration 2.6.9).

1. Draw a line connecting the two points (A and B on Illustration 2.6.9).

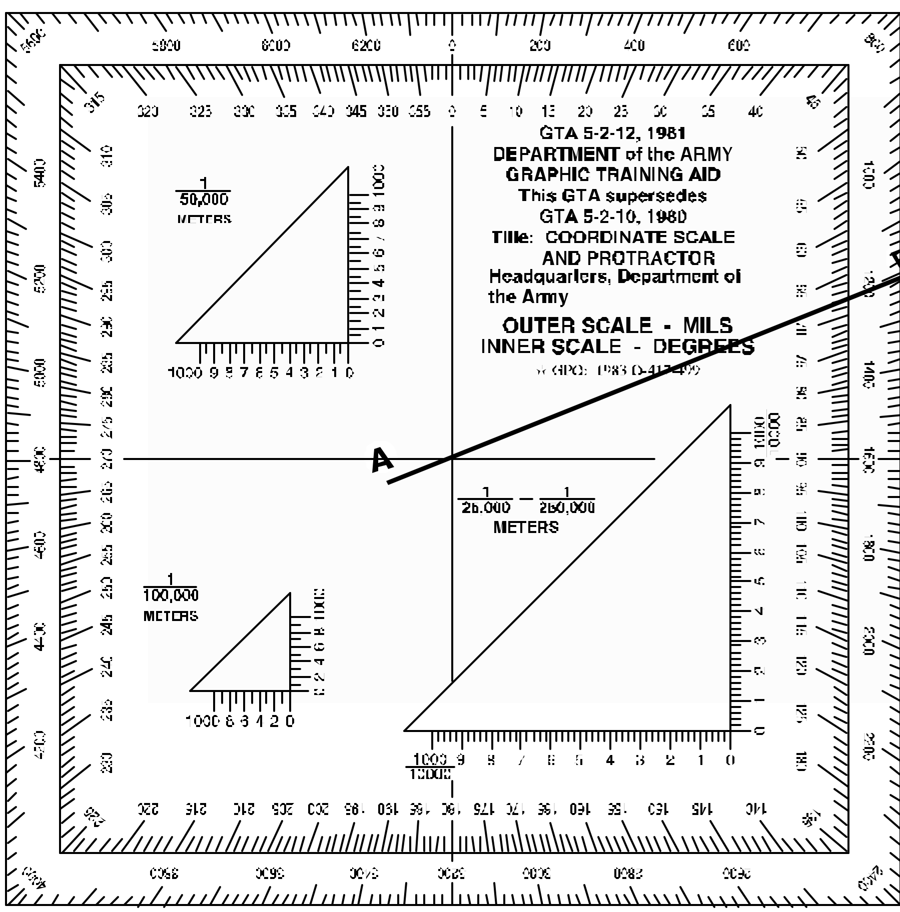


Illustration 2.6.9

2. Place the index of the protractor at the point where the drawn line crosses a vertical (north-south) grid line.

3. Keep the index at that point and align the 0 – 180 degree line of the protractor on the vertical grid line.

4. Read the value of the angle from the scale. This value is the grid azimuth from point A to point B, or 68 degrees in our example.

PLOTTING A GRID AZIMUTH

Use the following steps to plot an azimuth from a known point on a map (see Illustration 2.6.10). For this example, you will not have to convert the azimuth from magnetic to grid.

1. Place the protractor on the map with the index mark at the center of mass of the known point and the 0 – 180 degree base line parallel to a north-south grid line. (Use BM 145 on State Route 103.)

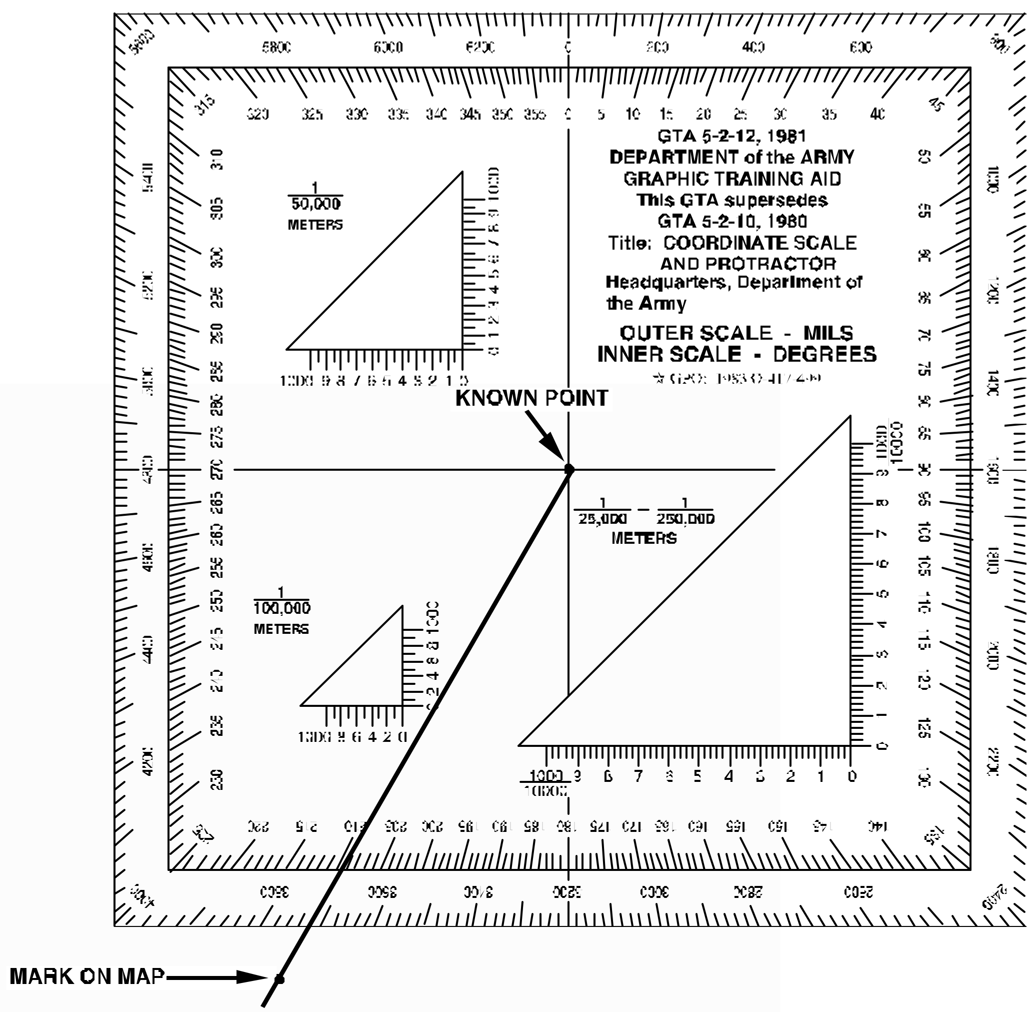


Illustration 2.6.10

2. Make a mark on the map at the desired azimuth. (Use an azimuth of 210 degrees.)

3. Remove the protractor and draw a line connecting the known point and the mark on the map. This is the grid direction line or grid azimuth. (**NOTE:** Distance has no effect on azimuths.)

PROCEED WITH CAUTION!

When measuring azimuths on a map, remember that you are measuring from a starting point to an ending point. If you make a mistake and you take the reading from the ending point, the grid azimuth will be opposite, thus causing you to go in the wrong direction.

CONCLUSION

Regardless of where you live, you need a way of expressing direction that is accurate and has a common unit of measure. Simply expressing, "to the right of that ...," may not be sufficient. The use of azimuths, compasses, protractors, and maps, will improve the accuracy of your directions.